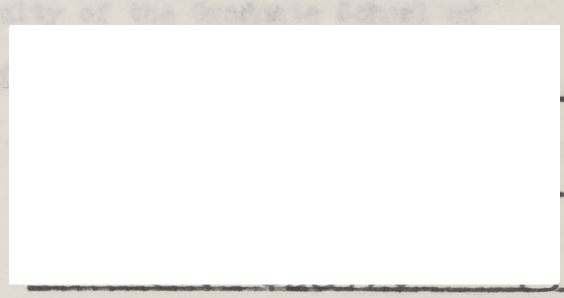
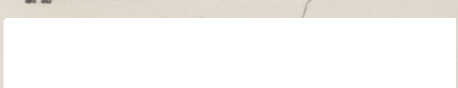
GEOLOGY OF THE Mc. NEIL, WATTERS PARK AREA

TRAVIS COUNTY, TEXAS

Approved:



Approved:



Dean of the Graduate School.

June 3, 1937.

GEOLOGY OF THE Mc. NEIL, WATTERS PARK AREA
TRAVIS COUNTY, TEXAS

THESIS

Presented to the Faculty of the Graduate School of
The University of Texas in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

By

Aubrey Brittain Mc Collum, B. A.
(Mason, Texas)

Austin, Texas

June, 1932

PREFACE

The writer wishes to extend his deepest appreciation to Dr. F. L. Whitney, who suggested the subject for this paper. Whatever degree of success that may have been attained in preparing this report is due to the untiring efforts and valuable instruction offered by Professor Whitney.

During the greater part of the time the writer was in the field he was assisted by Mr. Claude Fletcher, to whom much credit is due.

TABLE OF CONTENTS

M A P S

INTRODUCTION

The region under discussion in this report lies north of Austin in Travis County, Texas. It includes that part of the Austin quadrangle shown in figure 1 and is bounded on the east and west by meridians 97°40' and 97°50' respectively, on the south by parallel 30°20', and on the north by the Williamson County line. The area contains approximately eighty square miles.

The writer will endeavor to give an account of the geology of the area, paying particular attention to the stratigraphy and giving geological sections when such are obtainable. The descriptions and conclusions here presented are largely the result of field examinations made by the writer.

Much geologic work has been carried on in Travis County by the United States Geological Survey, and many detailed studies of the various formations have been made by students of the profession. The writer has made use of this previous knowledge, some of which is not in harmony with his observations.

PHYSIOGRAPHY

According to Hill,[1] there are two major geographical districts

---

[1] Hill, R. T.: "Geography and Geology of the Black and Grand Prairies," U. S. Geol. Survey, Twenty-First Ann. Rept., pt. VII, p. 500, 1900.

lying north of the Colorado River in Travis County. These two districts are divisible by the line of the Balcones fault which trends northeast across the county from the vicinity of Manchaca toward Round Rock in Williamson County. The country west of this line is that of the Lampasas Cut Plain, while the Black Prairie country lies to the east of it.

LAMPASAS CUT PLAIN

The Lampasas Cut Plain which lies to the west of the Balcones fault line is a part of that physiographic province which is known in Texas as the Hills Section. It is capped by the Edwards limestone on the highest summits, which in this area reach an elevation of 1,025 feet in the extreme western portion. These summits slope southeast to Colorado River just west of Austin, where they attain an elevation of 500 feet, the highest point on the eastern margin of the Cut Plain being just northeast of Spicewood Springs.

BLACK PRAIRIE REGION

> That area which is situated to the east of the Balcones fault line, although presenting within itself several diverse features, constitutes a portion of the great physiographical feature known as the Atlantic Costal Plain. This portion of the plain represents its older, higher, and more erroded interior margin, and in general, except along the southeastern and western margins, is largely a region of undulating upland prairie, mostly of the type which is known in Texas as rolling prairie land and which has been called the Black-Prairie. The highest points of this plain rarely rise over 750 feet above sea level.[2]

---

[2] Hill, R. T., and Vaughan, T. W.: "Description of the Austin Quadrangle," U. S. Geol. Survey., Atlas No. 76, 1903, p. 2.

Figure 1.- Sketch map of the Austin quadrangle, showing location of area described.

BALCONES FAULT ZONE

A pronounced seaward-facing fault scarp, known as the Balcones fault, bisects the area under discussion, dividing it into two major physiographical regions, which have already been discussed. This fault line, which is the major topographic feature, enters the area just south of Spicewood Springs, (pl. I), and trends northeast, playing out a short distance northeast of Merrilltown. Seen from the more open and level country on the east, the scarp appears as a sharp line of cedar-covered hills, the highest summits of which are about 400 feet above the lower plain.

The fault zone consists of a number of nearly parallel normal faults that are concentrated within a narrow strip of country. West of the main fault zone there is very little faulting; on the east side there are a number of small faults with no great amount of displacement. As a result of the faulting, the beds are thrown up into a number of blocks that are tilted at various angles.

The total displacement near Austin, as found by Hill,[3] is about 500 feet. It increases from north of south, and is about 1,000 feet at Uvalde, Medina County. The downthrow is on the east side of the fault.

DRAINAGE

This area is drained by Colorado River and by two of its smaller tributaries, Bull Creek, which drains that part of the country lying

---

[3] Hill, R. T.: "Geography and Geology of the Black and Grand Prairies," U. S. Geol. Survey, Twenty-first Ann. Rept., pt. 7, p. 501, 1901.

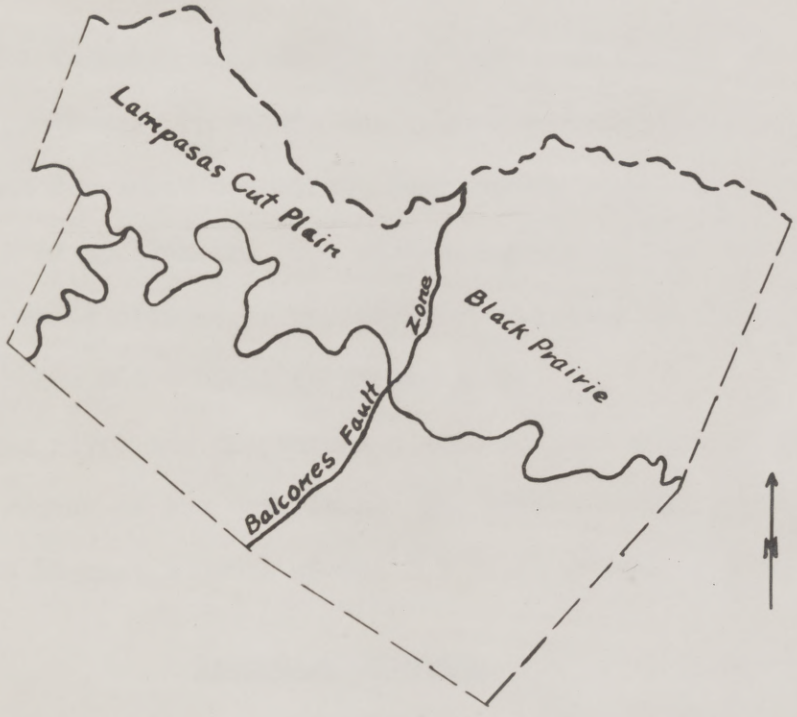


Figure 2. - Map of Travis County, Texas, showing major geographical districts, and the Balcones fault zone.

west of the main fault line, and Walnut Creek, which drains that part of the area lying east of the fault line.

Colorado River

> The Colorado River rises in the breaks of the Llano Estacado and empties into the Gulf of Mexico. It meanders across the Austin Quadrangle in great ox-bows, and occupies a deep valley some 500 feet below the present summit level of the Coastal Plain.[4]

The Colorado extends through only a very small portion of the area under discussion. It enters the region at its southwesternmost margin, flows northeast for about two miles, turns south, and leaves the area in the vicinity north of Mt. Barker. The stream, except in time of flood, is not copious. It may be classed as permanent or constant in flow, although it is variable in volume and subject to great floods.

The river has entrenched a deep valley, which is sharply canyoned in the region of the Cut Plain. The bottom of this canyon is 500 feet below the highest summits of the Cut Plain at the western boundary.

Secondary Streams

The principal secondary streams are those already mentioned, Bull Creek and Walnut Creek. The former carries the waters of the Cut Plain to the Colorado. It may be called an intermittent stream, as it presents alternating stretches of running water and dry bottom. Walnut Creek, which drains the waters of the Black Prairie into the Colorado, is an intermittent stream that has no water except in times of rainfall.

These streams have very different characters in the two greater topographic divisions. In the region of the Cut Plain they are entrenched

---

[4]Hill, R. T., and Vaughan, T. W.: "Description of the Austin Quadrangle," U. S. Geol. Survey, Atlas No. 76, p. 2, 1903.

in deep and narrow limestone canyons, whereas in the region of the Black Prairie the streams flow through valleys with rounded slopes of clay or gravel.

GEOLOGY

The rocks of this region are of sedimentary origin and belong to the Cretaceous system. They consist of various beds of marl, clay, limestone, shale, and sandstone.

West of the main fault zone, the summit formation is the base of the Edwards limestone, which dips parallel to the surface slopes or about 14 feet to the mile according to Hill.[5] Underlying the Edwards limestone are the Comanche Peak, Walnut, and Glen Rose formations, all of which outcrop in this area. The Glen Rose constitutes the cliffs that form the walls of Colorado River and Bull Creek canyons. West of the fault zone the topography is very rough and uneven, and consists chiefly of high summits and deep canyons. The formations exposed in this region range from the Glen Rose, which forms the walls of the canyons, up to the Edwards, which caps the highest summits. East of the fault the country is gently rolling. The Cretaceous strata have an increase in dip and disappear under the more gradual slope of the Tertiary formations.

STRATIGRAPHY

General Features

The deposits that form this area belong to the Cretaceous system,

---

[5] Hill, R. T.: "Geography and Geology of the Black and Grand Prairies," U. S. Geol. Survey, Twenty-first Ann. Rept., pt. 7, p. 501, 1901.

and include only the formations shown in the following classification:

GULF SERIES

Colorado Division

Austin chalk

Eagle Ford shale

COMANCHE SERIES

Washita Division

Buda limestone

Del Rio clay

Georgetown limestone

Fredericksburg Division

Edwards limestone

Comanche Peak limestone

Walnut clay

Trinity Division

Glen Rose formation

CRETACEOUS SYSTEM

The Cretaceous strata are the most widespread of any in the Texas geologic section. The deposits are marine and represent deposition in shallow or moderately deep water. They rest unconformably upon the older Paleozoic rocks. They comprise mostly limestones and clays, but there are sometimes beds of sand and sandy mixtures, occasionally with ad-

mixtures of silica. The limestones are predominantly light colored, chalky in texture and composition, and few have the hard ringing character found in the older limestones. The clays are likewise very chalky, and on exposure to air they readily crumble and weather into soils.

In Texas the Cretaceous system has been subdivided into two great series, the Lower Cretaceous or Comanche, and the Upper Cretaceous or Gulf series. These have, in turn, been divided into smaller groups called "divisions," each division embracing two or more formations.

Comanche Series

The Comanche series has been divided into three parts, which from the lowest to the highest are as follows: the Trinity, the Fredericksburg, and the Washita divisions.

Trinity Division

In central Texas the Trinity division has been subdivided into two parts, the lower or Travis Peak formation, which does not outcrop in this area, and the upper or Glen Rose formation.

Glen Rose Formation

The Glen Rose constitutes a great portion of the Lampasas Cut Plain, and is, with the exception of the Edwards, the most widespread formation in that section. It is composed of evenly bedded, argillaceous, chalky limestones that alternate with thin beds of marly, arenaceous clay, which are gray, white, or yellowish in color. These beds are fairly uniform throughout their extent. The entire thickness at Austin, according to Udden,[6] is 600 feet.

---

[6]Udden, J. A., and Baker, C. L., Boese, Emil: "Review of the Geology of Texas," Univ. of Texas. Bull. 44, Third Ed., 1919, p. 66.

The erosion of this formation presents a very rugged landscape. Due to the alternation of soft marls and hard limestones it weathers into numerous small cliffs that present a bench-and terrace effect along the slopes and hills of the Cut Plain.

Fredericksburg Division

The Fredericksburg division has been subdivided into three parts named from below upward: the Walnut clay, the Comanche Peak limestone, and the Edwards limestone.

Walnut Clay

The Walnut formation is composed of alternations of calcareous clays, semi-crystalline limestone flags, and shell agglomerates. These grade upward without break into the more chalky beds of the Comanche Peak. The Walnut varies in thickness from 80 to 100 feet in this area.

The following is a section given by Horne:[7]

On Road from Spicewood Springs to Bull Creek
Eight Miles North of Austin

Edwards		
Comanche Peak:		
# 5.	Flaggy, Chalky beds	10' 0''
Walnut:		
# 4.	Massive limestone with Estheria, algae, foraminifera bed, cherty limestone	40' 0''
# 3.	Nodular soft, chalky limestone	10' 0''
# 2.	Clay with Exogyra texana and a few Gryphaea marcoui	20' 0''
# 1.	Massive limestone	10' 0''
Glen Rose		

[7] Horne, S. W.: The Stratigraphy of the Walnut Formation in Lampasas, Williamson, Travis, Hays, and Comal Counties, Texas, Thesis manuscript, p. 34, 1930.

The following is a section taken by the writer:

Edwards

Comanche Peak

Flaggy chalky limestone	5' 0''
Soft nodular limestone	7' 6''

Walmut

Massive cherty limestone	10' 0''
Nodular limestone	41' 0''
Clay with Exogyra texana, Gryphaea marcoui	15' 0''
Clay layers and heavy limestone	14' 0''
T o t a l	92' 6''

Glen Rose

Comanche Peak Formation

The Comanche Peak formation rests upon the Walmut clay and lies below the flint and rudistid beds of the Edwards limestone. It is composed of flaggy beds of white chalky, fossiliferous limestone. Its thickness varies from 10 to 12 1/2 feet in the area.

Edwards Limestone

The Comanche Peak grades upward into the Edwards limestone without any break and changes from argillaceous and marly limestones to purer, whiter, and harder limestones. The Comanche Peak reaches its upper limits with the appearance of flints and the rudistid fauna, which usher in and characterize the Edwards formation throughout.

Much of the Edwards limestone was deposited in clear oceanic waters, uncontaminated by land debris, and where great colonies of animals such as sponges and rudistids could thrive.

The formation is a massive, heavy-bedded, crystalline limestone which attains a high degree of purity. These beds vary from hard, ringing,

durable strata to soft chalk. The beds also vary in texture. Some are impervious and others are very porous. Some are homogeneous throughout; others have hard and soft spots. The massive beds are broken in some places by thinner layers of chalky, marly lime. Clay is absent except as a minor constituent in exceptional marly layers. Iron is present sparingly as pyrites, and is betrayed by the red color which shows up in the softer phases. Occurring in layers throughout the formation are various flints and cherts. The flint nodules occur in many shapes and colors and vary from about one inch to one foot in diameter. These flints are noteworthy because they occur only in the Edwards in this locality. The Edwards presents very peculiar features of weathering. In some places weathering has produced a honeycomb appearance that consists of numerous small cavities in the rock. This type is called "honeycomb" weathering. Another type presents a miniature of a drainage system, exhibiting the small rivulets separated by divides opening downward into a wider channel. This type is called "karrenfelder" weathering. Near Austin, the thickness of the Edwards limestone is estimated to be about 300 feet.[8]

Washita Division

This division has been subdivided into three parts, which are from below upward: Georgetown limestone, Del Rio clay, and Buda limestone.

Georgetown Formation

The Georgetown formation in this area occurs just east of the main fault line, and because of structural disturbances in the Balcones fault zone it is difficult to measure a complete section. The formation

---

[8] Udden, J. A., Baker, C. L., Boese, E.: "Review of the Geology of Texas," Univ. of Texas Bull. No. 44, Third Ed, 1919, p. 68.

consists of alternating beds of hard, impure limestone and softer beds of marl and clay. In general, the limestone is hard, and is bluish-gray where fresh and becomes yellowish-white on weathering. Some parts are rather nodular.

The following is a detailed description of the Georgetown formation as given by Cuyler:

> The basal 13 feet of the formation at Austin is characterized by a rather soft, chalky limestone. Above this occurs about 33 feet of alternating beds of yellowish, hard and soft material. It is in this division of the section that the most of the fossils are found. This middle part of the section looks very much like the Ft. Worth of north Texas, and has in it the characteristic fossils of that formation; hence we may see the reason why the present Georgetown formation was formerly called the Ft. Worth limestone. Above this alternating material may be found a bed of yellowish or reddish calcareous shale which is about four feet thick. Hard marly material, yellowish in color after exposure, is next encountered for about nine feet. The top of the Georgetown at Austin is marked by a hard, massive, blue limestone which frequently caps some of the hills around Austin.[9]

The following is a section of the Georgetown at Austin, Texas as given by Hill:[10]

Georgetown Formation

	Feet
Massive brownish limestone studded with *Kingena wacoensis*	2.0
Softer lime material	8.6
Grayish limestone with irregular fracture; carries *Alectryonia carinata* and *Gryphaea washitaensis*.....	1.0
Yellow or reddish calcareous shale	4.3.
Alternating layers of hard and soft limestone with *Alectryonia carinata*, *Gryphaea washitaensis*, *Exogyra americana*, and *Lima wacoensis*	18.0

[9] Cuyler, R. H.: *Georgetown Formation of Central Texas and its North Texas Equivalents*, Thesis manuscript, 1927, pp. 5, 6.

[10] Hill, R. T.: "Geography and Geology of the Black and Grand Prairies," *U. S. Geol. Survey, Twenty-first Ann. Rept.*, pt. 7, 1901, p. 265.

Hard grayish limestone	33.0
Soft chalky limestone	13.0
T o t a l	79.9

Edwards Limestone

An attempt was made to measure a section of the Georgetown just south of Pilot Knob in northern Travis County, but due to the faulting and great amount of covering material in the faulted region it was impossible to get a detailed section; the thickness, however, was found to be somewhere in the neighborhood of 80 feet or probably a little more.

In some parts of Travis County the Georgetown formation consists of six members:[11]

	Thickness	Lithology
Main Street	15-20	Limestone
Weno	10-15	Nodular limestone
Denton	2	Shell marl
Ft. Worth	30	Marly limestone
Duck Creek	25	Nodular limestone
Kiamichi	2	Clays

In other parts of Travis County the two lower members, the Duck Creek and the Kiamichi, are missing.

Kiamichi

This is the lowest member of the Washita group and lies between the Edwards formation and the Duck Creek member of the Georgetown. It con-

[11] Cuyler, R. H.: Georgetown Formation of Central Texas and its North Texas Equivalents, Thesis manuscript, 1927, p. 75.

sists of shaly clay which is yellowish-green in color. This yellowish color is due to the presence of pyrites, which upon weathering alter to limonite. Where these clays have not been exposed to weathering they are dark in color.

A list of Kiamichi fossils:

Gryphaea navia Hall

Exogyra texana (Roemer)

Oxytropidoceras belknapi (Marcou)

Duck Creek

The Duck Creek is in most places a chalky, argillaceous, nodular limestone with smaller amounts of limy marl. Its fresh color is dark gray, bluish or generally blackish; its weathered color whitish. The formation is soft and forms mostly receding layers in cliffs.

A list of Duck Creek fossils:

Exogyra americana Marcou

Gryphaea washitaensis Hill

Protocardia texana (Conrad)

Neithea bellula (Cragin)

Enallaster texanus (Roemer)

Neithea subalpina (Boese)

Ft. Worth

The Ft. Worth member is a chalky, argillaceous nodular limestone, blackish or bluish-gray on exposure, becoming whitish when weathered It is harder than the Duck Creek member.

A list of Ft. Worth fossils:

Neithea bellula (Cragin)

Neithea subalpina (Boese)

Neithea wrightii (Shumard)

Exogyra americana (Marcou)

Gryphaea washitaensis Hill

Pleurotomaria austinensis Shumard

Alectryonia carinata Lamarck

Macraster elegans (Shumard)

Denton

The Denton shell marl presents a prominent Gryphaea agglomerate about the middle of the Georgetown. On fresh exposure it is a bluish-gray very shelly calcareous marl; on prolonged exposure its surface is a weathered concentrate of shell fragments, mostly Gryphaea washitaensis. It contains a few thin clayey limestone layers.

A list of Denton fossils:

Gryphaea washitaensis Hill

Alectryonia carinata Lamarck

Neithea texana (Roemer)

Neithea subalpina (Boese)

Protocardia sp.

Lima wacoensis Roemer

Weno

The Weno consists of a fairly well bedded, argillaceous, nodular, gray limestone and limy marl. These two materials occur in alter-

nating beds, and the whole member is softer than the overlying Main Street cap. In bluffs the Weno forms a receding ledge, and on uplands it produces a sloping prairie.

A list of Weno fossils:

Neithea georgetownensis Knicker

Alectryonia carinata Lamarck

Protocardia texana (Conrad)

Trigonia clavigera Cragin

Turritella sp.

Main Street

This member forms the hard cap of the Georgetown formation. It is harder, more crystalline, and less marly than other members of the Georgetown. It consists of nodular, slightly argillaceous limestone, bluish in color and becoming white on weathering.

A list of Main Street fossils:

Exogyra arietina Roemer

Alectryonia carinata Lamarck

Kingena wacoensis Roemer

Turrilites brazoensis Roemer

Gryphaea washitaensis Hill

Holectypus limitis Boese

Del Rio Clay

This formation marks a break in the monotonous sequence of the limestone beds. It possesses characteristics which make it easily recognizable. It is a peculiar greenish-blue, laminated clay, which weathers to

a dull yellowish-brown color. In places it contains thin slabs of shell breccia composed of Exogyra arietina, forming massive agglomerates from one inch to six inches in thickness. Near the top of the formation thin layers of arenaceous limestone are found. The clay carries pyrite in places and when it disintegrates these pyrite concretions oxidize and decompose. The resulting iron rust gives the dry surface of the clay beds a dull yellowish color. The most readily distinguishable features of the clay are its color, as mentioned above; the enormous quantities of a most easily recognizable fossil, Exogyra arietina, which occurs by the millions either in consolidated slabs known as flags or independently throughout the formation; and lastly, the formation is usually covered by a dense growth of mesquite trees.

Section on South Side of Pilot Knob in Northern Travis County, Near the Williamson County Line

Buda

Del Rio:

	Feet
Yellowish-brown clay thinly studded with Exogyra arietina	30.5
Arenaceous flaggy bed	0.5
Clay beds containing numerous Exogyra arietina and Exogyra arietina agglomerates	19.5
Exogyra arietina beds with limonite nodules..	18.0
Talus, covered	10.0
T o t a l	78.5

Georgetown

Buda Limestone

The Buda limestone is the uppermost of the three formations of

the Washita division, and also the uppermost bed of the Comanchean. It is a whitish to yellowish-brown limestone with blotches of pale pink. It is white and thinly bedded in the lower part. These beds weather into shattered, lumpy material, while those above are harder, more massive reddish or blotched with yellow, and weather into smooth faced, regular beds. It has a thickness of 41 feet at Merrilltown.

Section 0.15 Miles on Road Southeast from Merrilltown

Eagle Ford

Buda

	Feet
Hard massive limestone, reddish in color	10.5
Thinly bedded, soft nodular limestone	9.0
Hard, heavy bedded, reddish limestone	10.0
Soft, white, nodular limestone	11.5
T o t a l	41.0

Del Rio

Gulf Series

The Gulf series includes from below upward, the Eagle Ford shales, Austin chalk, Taylor marl, and the Navarro beds. Only the first two mentioned, the Eagle Ford shales and the Austin chalk, are found in this region. They appear on the east side of the fault zone, the chalk being the most widely distributed formation in the area.

Eagle Ford Shale

In the region under discussion the Eagle Ford shale rests directly and unconformably upon the Buda limestone. The formation is strati-

graphically and unconformably overlain by the Austin chalk. It consists of laminated clays, shales, and impure limestones, usually blue or black when unweathered, but becoming light yellow and white on exposure. An especially noteworthy feature is the occurrence of the remains of fishes, some of the more flaggy layers containing numerous fish teeth. Also thin beds of volcanic ash known as bentonite are interstratified with the clays. Nodules of pyrite from half an inch to two inches in diameter are common. A section which was measured about one quarter of a mile south of Watters Park had a thickness of 43.5 feet.

Section One Quarter of a Mile South of Watters Park, Travis County, on Walnut Creek

Austin chalk

Eagle Ford shale

	Feet
Extremely thinly laminated shale, brownish in color, containing large ammonites	1.0
Blue shale with thin flagstone partings	24.0
Sandy calcareous flagstones alternating with shale partings and bentonite seams	14.5
Blue shale, very thinly laminated	4.0
T o t a l	43.5

Buda limestone

Austin Chalk

This formation consists of fairly thick beds of impure chalk, interstratified with softer beds of marl. The water-saturated beds underground are bluish, but the air-dried indurated surface is glaring white.

In composition it varies from 85% to 94% calcium carbonate, the residue consisting of magnesia, silica, and a small percentage of ferric oxide.[12]

Small nodules of marcasite are common in the fresh chalk. On exposed surfaces streaks of rust radiate from these nodules and locally discolor the face of the rock. In the upper part marly and shaly beds begin to predominate. These alternate with thick layers of chalk. The highest part of the formation consists entirely of bluish-yellow marls with thin beds of limestone. The Manor wells show the thickness to be 410 feet.[13]

STRUCTURE

When the formations which are now exposed were originally deposited in the sea, they were practically horizontal. Since their deposition the region has been gradually elevated without serious deformation except faulting and the tilting of beds. These beds, therefore, instead of being horizontal, are now slightly inclined toward the gulf. Since they were elevated above sea level and tilted, these beds have been eroded so that the surface no longer coincides with the surface of the uppermost layers of the rock, but slopes off the gently inclined layers at a slight angle. The different formations are exposed to view in order of their age. The lowermost formation is exposed at the greatest distance from the coast; the uppermost nearest to the coast.

The formations of the area represent practically the whole

---

[12] Hill, R. T., and Vaughan, T. W.: "Geology of the Edwards Plateau and Rio Grande Plain Adjacent to Austin and San Antonio, Texas.," U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, 1897, p. 239.

[13] Loc. cit.

the Cretaceous period. Every formation from the Glen Rose through the Austin chalk is exposed. This is due to the complicated system of faulting which was developed incident to the formation of the Balcones escarpment. The main fault line lies between the Edwards limestone on the west and the Austin chalk on the east. It has a general trend of N 30 E and has a throw of about 1000 feet at Austin. In the northern part of the area the main fault line is not continuous but consists of a number of short faults overlapping.

The formations of the Lampasas Cut Plain are affected very little by the Balcones fault except for an occasional minor fault and slight jointing and dragging immediately along the margin. East of the main fault there is a zone of minor faulting which involves the Georgetown and the younger formations of the Cretaceous period.

BIBLIOGRAPHY

1. Adkins, W. S.: "Handbook of Texas Cretaceous Fossils," Univ. of Texas Bull. No. 2838, 1928.

2. Cuyler, R. H.: Georgetown Formation of Central Texas and its North Texas Equivalents, Thesis manuscript, 1927, p. 75.

3. Hill, R. T.: "The Cretaceous Rocks of Texas and Their Economic Value," Geol. Survey of Texas First Ann. Rept., 1898.

4. _____ "The Geography and Geology of the Black and Grand Prairies of Texas," U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, 1901.

5. Hill, R. T., and Vaughan, T. W.: "Description of the Austin Quadrangle," U. S. Geol. Survey Atlas No. 76, 1902.

6. _____ "Geology of the Edwards Plateau and Rio Grande Plain Adjacent to Austin and San Antonio, Texas With Reference to the Occurrence of Underground Waters," U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, 1897.

7. Horne, S. W.: The Stratigraphy of the Walnut Formation in Lampasas, Williamson, Travis, Hays, and Comal Counties, Texas, Thesis manuscript, 1930.

8. Taff, J. A., and Leverett, S.: "Report on the Cretaceous Areas North of the Colorado River," Texas Geol. Survey Fourth Ann. Rept., 1893.

9. Udden, J. A., Baker, C. L., and Boese, E.: "Review of the Geology of Texas," Univ. of Texas Bull. No. 44, Fourth Edition, 1919.

10. Whitney, F. L.: "Bibliography and Index of North American Mesozoic Invertebrata," Bull. of American Paleontology, Vol. XII, No. 48.

PLATE-I

MAP SHOWING GEOLOGY OF Mc. NEIL, WATERS PARK AREA

TRAVIS CO.

Mc. Neil

B.M. 837

Pilot Knob (North)

Merrilltown

R.V.

B.M. 797

Duval

Walters

FAULT

B.M. 758

BALCONES

ANTICLINE

NORTHWESTERN

A.N.D.

Fiskville

Spicewood Springs

Hill

1000

900

800

700

LEGEND

- AUSTIN CHALK
- EAGLE FORD
- BUDA
- DEL RIO
- GEORGETOWN
- EDWARDS
- COMANCHE PEAK
- WALNUT
- GLEN ROSE
- —— FAULT
- ---- CONCEALED FAULT

1 0 1 2 Miles

SCALE